Reaffirmed: 11/07

Safety Standards

of the

Nuclear Safety Standards Commission (KTA)

KTA 1503.1 (06/02)

Surveilling the Release of Gaseous and Aerosol-bound Radioactive Substances
Part 1: Surveilling the Release of Radioactive Substances with the Stack Exhaust Air During Specified Normal Operation

(Überwachung der Ableitung gasförmiger und an Schwebstoffen gebundener radioaktiver Stoffe
Teil 1: Überwachung der Ableitung radioaktiver Stoffe mit der Kaminfortluft bei bestimmungsgemäßem Betrieb)

The previous version of this safety standard was issued 06/93

If there is any doubt regarding the information contained in this translation, the German wording shall apply.

Editor:

KTA-Geschaeftsstelle c/o Bundesamt fuer Strahlenschutz (BfS)

Willy-Brandt-Str. 5 • 38226 Salzgitter • Germany

Telephone +49-1888/333-(0) 1621 • Telefax +49-1888/333-1625

KTA SAFETY STANDARD

June 2002	**Surveillance of the Release of Gaseous and Aerosol-bound Radioactive Substances; Part 1: Surveillance of the Release of Radioactive Substances with the Stack Exhaust Air During Specified Normal Operation**	KTA 1503.1

Previous versions of this safety standard: 2/79 (BAnz. No. 133 of July 20, 1979)
6/93 (BAnz. No. 211a of November 9, 1993)

CONTENTS

KTA-Geschaeftsstelle c/o BfS, Willy-Brandt-Str. 5, 38226 Salzgitter, Germany

Comments by the editor:

Taking into account the meaning and usage of auxiliary verbs in the German language, in this translation the following agreements are effective:

shall	indicates a mandatory requirement,
shall basically	is used in the case of mandatory requirements to which specific exceptions (and only those!) are permitted. It is a requirement of the KTA that these exceptions - other than those in the case of **shall normally** - are specified in the text of the safety standard,
shall normally	indicates a requirement to which exceptions are allowed. However, the exceptions used shall be substantiated during the licensing procedure,
should	indicates a recommendation or an example of good practice,
may	indicates an acceptable or permissible method within the scope of this safety standard.

Fundamentals

(1) The safety standards of the Nuclear Safety Standards Commission (KTA) have the task of specifying those safety related requirements which shall be met with regard to precautions to be taken in accordance with the state of science and technology against the hazards arising from the construction and operation of the facility (Sec. 7 para. 2 no. 3 Atomic Energy Act), in order to attain the protective goals specified in the Atomic Energy Act and the Radiological Protection Ordinance (StrlSchV) and which are further detailed in "Safety Criteria for Nuclear Power Plants" and in "Guidelines for the Assessment of the Design of Nuclear Power Plants with Pressurized Water Reactors against Incidents pursuant to Sec. 28 para. 3 of the Radiological Protection Ordinance (StrlSchV) - Incident Guidelines".

(2) The permanently installed and the mobile radiation protection instrumentation, among other equipment, serves in protecting the persons inside and outside of the facility from ionizing radiation, in ascertaining the specified normal functioning of the equipment for keeping solid, liquid and gaseous radioactive substances within the intended enclosures, as well as in handling and the controlled conduction of the radioactive substances within the facility and for surveilling the release of radioactive substances. The safety standards of the series KTA 1500 specify concrete safety related requirements with regard to this instrumentation.

(3) Safety standard KTA 1503 deals with requirements regarding technical equipment and additional organizational measures considered necessary with respect to surveilling the emission of gaseous and aerosol-bound radioactive substances. It is comprised of the following parts:

Part 1: Surveilling the release of radioactive substances with the stack exhaust air during specified normal operation,

Part 2: Surveilling the release of radioactive substances with the stack exhaust air during design-basis accidents,

Part 3: Surveilling the non-stack discharge of radioactive substances.

(4) As specified under Secs. 47 para. 1 and 48 para. 1 StrlSchV, it is required that any uncontrolled discharge is prevented, that the released radioactivity is as low as possible, that the release is surveilled and, that the discharge specified by type and radioactivity is reported to the proper authority at least once a year. In accordance with these requirements, it is necessary that equipment for surveilling the release of radioactive substances is installed and operated. In accordance with Sec. 67 StrlSchV, this surveilling equipment is required to correspond to the state of the art in science and technology.

(5) Surveilling the stack release of radioactive substances with the stack air during specified normal operation shall serve in

a) creating a detailed assessment of the radioactive substances discharged with the stack exhaust air as one basis for evaluating the radiological effects,

b) automatically initiating alarm signals in the case of limit values being exceeded,

c) contributing to fulfilling the requirements in accordance with Sec. 48 para. 1 StrlSchV.

1 Scope

This safety standard shall apply to the equipment for surveilling the release of gaseous and aerosol-bound radioactive substances with the stack exhaust air of nuclear power plants with light water reactors during specified normal operation.

2 Definitions

2.1 Discharge rate

Discharge rate is the quotient of the discharged radioactivity and the time span over which this discharge occurred.

2.2 Release of radioactive substances

Release of radioactive substances is the discharge of liquid, aerosol-bound or gaseous radioactive substances from the facility along the paths designated for this purpose.

2.3 Aerosol monitor

Aerosol monitor is the common term for a monitor used for the continuous measurement of the radioactivity concentration of aerosol-bound airborne radioactive substance.

2.4 Response of a measurement device

Response of a measurement device is the ratio of the displayed value on the measurement device to the measured quantity causing the display.

2.5 Measurement-range factor

Measurement-range factor is the ratio between the end value of the scale of one measurement range and the end value of the scale of the next more sensitive measurement range.

2.6 Specified normal operation

Specified normal operation encompasses

a) operating processes for which the plant, assuming the able function of all systems (fault free condition), is intended and suited (normal operation);

b) operating processes which occur in the event of a plant component or system malfunction (fault condition) as far as safety related reasons do not oppose continued operation (abnormal operation);

c) maintenance procedures (inspection, servicing, repair).

2.7 Detailed assessment of radioactive substances

Detailed assessment is a special form of surveilling consisting of identifying, and determining the radioactivity of, the radionuclides or radionuclide groups discharged over a specified time span.

2.8 Decision limit

Cf. Section 2.14.2

2.9 Cumulative loss factor during sample extraction of airborne substances

The cumulative loss factor is a correction factor to be applied when determining the release of radioactive substances. It is composed, essentially, of factors that arise from changes in the concentration of air-borne substances

a) when determining a partial air stream with a sample extraction rake,

b) when extracting samples non-isokinetically,

c) during transport through the sample extraction lines (pipe factor),

d) during transport within the accumulating and measurement equipment.

2.10 Calibration of a measurement equipment for radiation surveillance

Calibration of a measurement equipment for radiation surveillance means determining the functional relationship between the display amplitude and the value of the measured quantity.

2.11 Measurement equipment

Measurement equipment includes the entirety of all measurement devices and auxiliary devices required for determining a measured quantity, for the passing on and adjusting of a measurement signal and for the display of the measurement value as an image of the measured quantity.

2.12 Measurement medium

Measurement medium is the sample extracted from the medium subject to surveillance that – if necessary, after procedural treatment such as heating up, filtering, thinning down – flows through the measurement volume (i.e. the region that was determined during calibration with respect to the response of the corresponding measurement device).

2.13 Mixed sample

Mixed sample is a mixture of the individual samples or cumulative samples or of parts of these samples taken over a specified time span.

2.14 Detection limit and decision limit of measurement equipment for a specific radionuclide or mixture of radionuclides

2.14.1 Detection limit

The detection limit for a specific radionuclide or mixture of radionuclides is that value of the measured quantity that shall be calculated in accordance with the equations under Section 2.14.3 on the basis of characteristic statistical quantities. The detection limit is used to check whether or not the measurement equipment is suited for the measurement purpose. To this end, the calculated detection limit is compared with a specified standard detection limit, e.g., one required for scientific, legal or other reasons.

Note:
Measured quantities are, e.g., radioactivity, radioactivity concentration, time integral of the radioactivity concentration.

2.14.2 Decision limit

The decision limit for a specific radionuclide or mixture of radionuclides is that value of the measured quantity that shall be calculated in accordance with the equations under Section 2.14.3 on the basis of characteristic statistical quantities. The decision limit is used in deciding whether or not the measured radioactivity is a contribution of the examined medium or merely of the measured background level.

2.14.3 Definition of the detection limit and the decision limit

Detection limit $G_N = f \cdot k_N \cdot S$

Decision limit $G_E = f \cdot k_E \cdot S$

The standard deviation, S, of the count rate is calculated as follows:

a) in case of an integral digital measurement

$$S = \sqrt{\frac{R_0}{t_0}\left(1+\frac{t_0}{t_m}\right)}$$

b) in case of an integral analog measurement

$$S = \sqrt{\frac{R_0}{2\tau}}$$

c) in case of gamma spectrometry

$$S = \sqrt{\frac{2b \cdot \overline{R}_0(E_\gamma)}{t_m}}$$

d) in case of alpha spectrometry

$$S = \sqrt{\frac{\sum R_0(E_\alpha)}{t_0}\left(1+\frac{t_0}{t_m}\right)}$$

e) in case of a differentiating measurement (aerosol monitor, iodine monitor):

An analytical procedure for determining the value of S is specified in DIN 25 482 Part 7.

Nomenclature:

G_N	detection limit	e.g., Bq
G_E	decision limit	e.g., Bq
f	calibration factor	e.g., Bq · s
k_N	factor of the statistical certainty at the detection limit	
k_E	factor of the statistical certainty at the decision limit Note: Numerical values for these characteristic statistical quantities are specified under Section 5.2.	
R_0	background pulse rate	s^{-1}
$\overline{R}_0(E_\gamma)$	average background pulse rate per channel or eV at the energy level E_γ	s^{-1}
b	base width of a gamma peak (base width of peak); b = 1.7 · h, with h being equal to the half-value width of the gamma peak	number of channels or eV
$\Sigma R_0(E_\alpha)$	count rate of background level in the vicinity of the alpha peak	s^{-1}
t_0	duration of background count rate measurement	s
t_m	measurement duration of the test sample or of the measurement medium	s
τ	time constant	s

The detection and decision limits of alpha-spectrometric measurements shall be calculated under the assumption that the sum of the channel contents beneath an alpha-peak is equal to an integral digital measurement with a single channel analyzer.

Note:
The cited equations deliver approximated values for practical use. They apply to cases where the background level pulse rate is not too low (> 20). Refer to DIN 25 482-1 (04/89), DIN 25 482-2 (09/92), DIN 25 482-3 (02/93) and DIN 25 482-10 (05/00) for details.

2.15 Representative sample (exhaust air)

A sample is considered as being representative if its examination allows determining the type and quantity of radioactive substances discharged with the stack exhaust air.

2.16 Pipe factor

Pipe factor is the ratio between the radioactivity concentration of a radionuclide or radionuclide group at the inlet opening of the sample extraction probe and the radioactivity concentration at the connection point of the accumulating or measurement equipment for surveilling gaseous or aerosol-bound radioactive substances in a stationary condition.

2.17 Cumulative sample

Cumulative sample is a sample created by a continuous extraction over a specified time span.

2.18 Aerosols

Aerosols are solid or liquid particles suspended in air or in a gas.

2.19 Surveillance / Surveilling

Surveillance is a collective term indicating any kind of controlled measurement of physical quantities including the comparison of the results with specified values.

Note:
The surveillance is performed, e.g., by

a) a continuous measurement or
b) an analysis of samples (e.g. in the laboratory) or
c) a correlation of measurement values

and, in each case, by comparing the results with specified values of the physical quantities (e.g. licensed values, operational values).

3 Measurement Objects and Measurement Procedures

3.1 General Requirements

(1) The type and radioactivity of discharged radioactive substances shall be determined in accordance with the requirements under this safety standard.

(2) With regard to the measurement procedures and radiological significance of the discharged radioactive substances a distinction shall be made between:

a) radioactive noble gases,
b) aerosol-bound radioactive substances,
c) radioactive gaseous iodine,
d) tritium,
e) radioactive strontium,
f) alpha emitters,
g) carbon 14.

(3) The continuous and discontinuous sample extractions and measurements for surveilling the release of radioactive substances shall normally be carried out within the exhaust air or on a partial stream of the exhaust air. The volumetric flow of these partial streams shall be subject to continuous surveillance.

(4) The volumetric flow of the exhaust air shall be continuously measured and automatically recorded. The measurement range shall extend from 25 % to 110 % of the nominal volumetric flow of the exhaust air. The measurement uncertainty for the volumetric flow of specified normal operation shall not exceed an absolute value corresponding to 5 % of the nominal volumetric flow.

(5) In the case of the continuous measurement of aerosol-bound radioactive substances and radioactive gaseous iodine, any deviation of the volumetric flow of the partial stream exceeding 20 % of the nominal flow shall automatically issue an alarm.

(6) Regarding the detailed assessment of aerosol-bound radioactive substances, radioactive iodine, tritium, radioactive strontium, carbon 14 and alpha emitters, the flow quantity shall be measured. Any deviation of the volumetric flow of the partial stream exceeding 20 % of the nominal flow shall automatically issue an alarm; this alarm is not required when piston pumps are used.

Note:
An overview of the required measurements is presented in **Table 3-4**. Examples for the surveillance equipment are illustrated in **Figure 3-1** to help in visualizing the requirements of this safety standard.

3.2 Radioactive Noble Gases

3.2.1 Continuous Measurement

(1) The release of radioactive noble gases with the exhaust air shall be subject to continuous surveillance by measuring the radioactivity concentration and the volumetric flow of the exhaust air. The radioactivity concentration shall be determined using twice redundant radioactivity measurement equipment and shall be surveilled with regard to limit values. At least one these measurement equipments shall enable surveilling the cumulative beta radioactivity of noble gases.

(2) In order to prevent any distortion of the measurement values, a high-efficiency particulate air filter in at least Filter Class H12 in accordance with DIN EN 1822-1 shall be installed in-line before the measurement equipment.

(3) The detection limit of the measurement equipment for measuring the radioactivity concentration shall not exceed $1 \cdot 10^4$ Bq/m^3 for xenon 133 over a measurement duration of ten minutes.

(2) Under consideration of the volumetric flow of the exhaust air, the measurement range of the measurement equipment shall enable surveilling discharge rates between $4 \cdot 10^9$ and $4 \cdot 10^{13}$ Bq/h relative to the nominal volumetric flow of the exhaust air.

3.2.2 Detailed Assessment

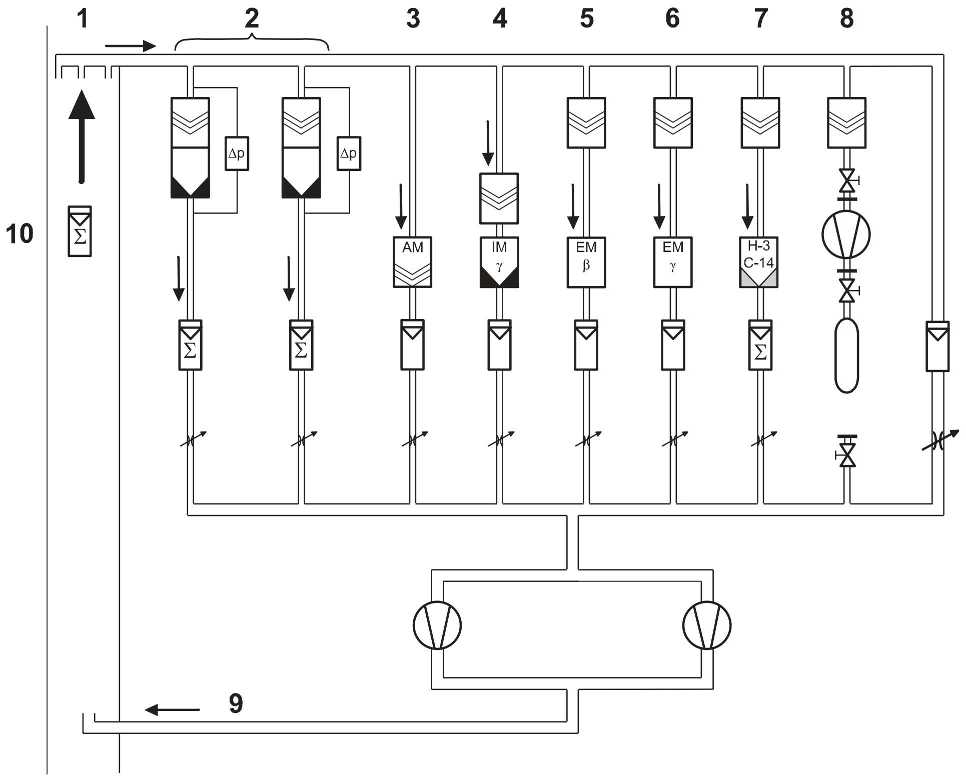
(1) The radioactive noble gases discharged with the exhaust air shall be subject to detailed assessment. This assessment shall be based on gamma-spectrometric measurements. The nuclides listed in **Table 3-1** shall be taken into consideration.

Radionuclide	Radionuclide
Argon 41	Xenon 131 m
Krypton 85	Xenon 133
Krypton 85 m	Xenon 133 m
Krypton 87	Xenon 135
Krypton 88	Xenon 135 m
Krypton 89	Xenon 137
	Xenon 138

Table 3-1: Radionuclides to be considered in the detailed assessment of radioactive noble gases

(2) The measurement equipment for the nuclide specific detailed assessment of radioactive noble gases shall be designed such that, with otherwise radioactivity-free air as measurement medium, a radioactivity concentration of $5 \cdot 10^2$ Bq/m^3 for the reference nuclide xenon 133 and $1 \cdot 10^4$ Bq/m^3 for krypton 85 can be determined within a maximum measurement duration of 24 hours.

(3) The measurement duration for the detailed assessment shall correspond to at least that measurement duration required to achieve the detection limits specified under para. 2.



1 Sample extraction equipment

2 Sample accumulation equipment for the detailed assessment of the radioactivity release of aerosol-bound radioactive substances and of iodine compounds

3 Aerosol monitor

4 Iodine monitor

5 Noble gas monitor (cumulative beta measurement)

6 Noble gas monitor and nuclide specific measurement equipment for the detailed assessment of the radioactivity release of radioactive noble gases

7 Sample accumulation equipment for the detailed assessment of the radioactivity release of tritium and carbon 14 compounds

8 Discontinuous sample extraction

9 Return pipe

10 Volumetric flow measurement in the stack

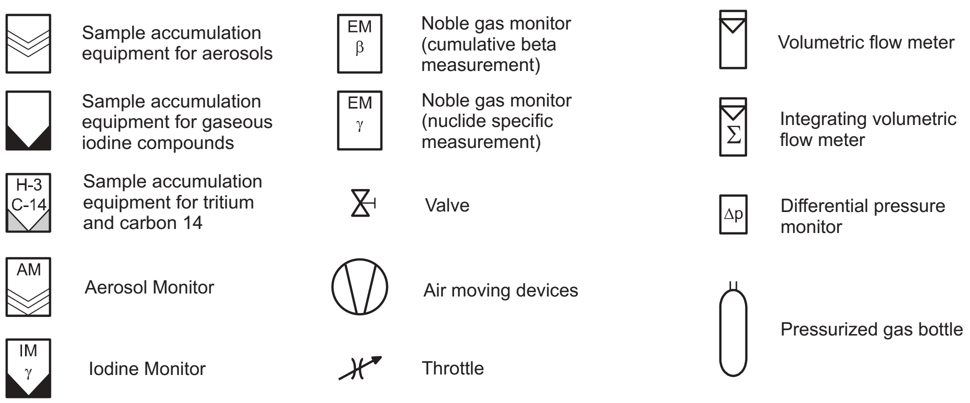


Figure 3-1: Example of the surveillance equipment

(4) Those radionuclides listed in **Table 3-1** which do not register shall be specified with the decision limit of the particular measurement equipment for the corresponding measurement.

(5) Any other radionuclides detected in the stack exhaust air in the course of determining the noble gas fraction shall be specified in the reporting form (cf. **Figure 7-1**) under noble gases as “Others”, even if they are not noble gases.

(6) The continuous measurement for the detailed assessment of radioactive noble gases shall basically rely on the spectra determined for the entire day. The results of the evaluations of the measured spectra determined in hourly intervals (or in time intervals less than or equal to 24 hours) shall be included in the detailed assessment only if radioactive noble gases are identified by these specific measurements, e.g. due to a short-term increase of the radioactivity discharge, which cannot be detected in the day spectrum. Should the continuous measurement for the detailed assessment of radioactive noble gases reveal that due to an increased release of radioactive substances a detection limit of $1 \cdot 10^4$ Bq/m^3 for krypton 85 is exceeded, then the contribution of krypton 85 to the cumulative release shall be determined, e.g., by sample extraction from the exhaust air.

(7) If the detailed assessment of the discharged radioactive noble gases is not performed on the basis of the primarily required continuous nuclide specific measurement, it shall, then, be based on the cumulative discharge rate determined from the beta measurement and taking the ratio of the individual nuclides within the nuclide composition into account. In this case the equipment for determining the discharge rate of radioactive noble gases shall be designed and constructed as specified under Section 3.2.1 as a twice redundant cumulative beta radioactivity measurement equipment. The discontinuous determination of the nuclide composition shall be performed once a week by extracting a representative sample. The samples shall be analyzed without delay. In case xenon 133 with a radioactivity concentration larger than $5 \cdot 10^2$ Bq/m^3 but no krypton 85 is detected in the measurement, then a second measurement of the sample shall be performed after a minimum decay time of two days to determine the radioactivity concentration of krypton 85.

(8) If a failure of the measurement equipment for the continuous nuclide specific assessment of radioactive noble gases occurs, then the basis shall be the cumulative discharge rate determined from the beta measurement and taking the ratio of the individual nuclides within the nuclide composition into account. The determination of the nuclide composition shall be performed by taking a representative sample once a week, with the measurement and evaluation of these samples to be performed as specified under para. 7.

(9) If the nuclide composition is determined discontinuously, then representative samples – in addition to the weekly samples – shall be taken and evaluated without delay whenever an upper limit value from the surveillance

a) of noble gases or

b) of aerosol-bound radioactive substances or

c) of iodine

responds.

(10) As long as any of the upper limit values are pending, the nuclide composition shall, if possible, be determined in hourly intervals.

(11) In case of a discontinuous extraction of samples, the nuclide composition shall be considered as unchanged in the time interval between two sample extractions.

3.3 Aerosol-bound Radioactive Substances

3.3.1 Continuous Measurement

(1) The discharge of aerosol-bound radioactive substances with the exhaust air shall be surveilled by a continuous measurement. For this purpose, the aerosol-bound radioactive substances shall be continuously deposited from a partial stream on a high-efficiency particulate air filter in at least Filter Class H12 in accordance with DIN EN 1822-1 and the radioactivity shall be continuously measured during this process.

(2) The measurement equipment shall be designed such that, given a previously uncharged high-efficiency particulate air filter, a short-term radioactivity concentration with a time integral of 4 (Bq/m^3)h within a maximum of one hour will cause the decision limit for the alarm display of the measurement value "Radioactivity on the Filter" or "Increasing Radioactivity on the Filter" to be exceeded.

(3) The measurement range of the measurement equipment shall be such that it will be possible to determine discharge rates from $4 \cdot 10^3$ through $4 \cdot 10^9$ Bq/h relative to the nominal volumetric flow of the exhaust air.

(4) The radioactivity on the filter shall be surveilled for a value at which a of release of $2 \cdot 10^8$ Bq inside one hour can still be detected with a maximum standard deviation of 10 %. The filter shall be exchanged when this value is exceeded and the released amount cannot anymore be determined with a maximum standard deviation of 10 %. Regardless of this condition, the filter shall be exchanged at least every 14 days.

(5) In the case of measurement equipment with filters that are continuously or intermittently in motion, an alarm limit value shall be set to a value such that a release rate of at least $2 \cdot 10^8$ Bq/h relative to the nominal volumetric flow of the exhaust air can still be detected.

(6) Cesium 137 shall be used as reference nuclide for the requirements specified under paras. 2 through 5.

3.3.2 Detailed Assessment

(1) A detailed assessment shall be performed for the aerosol-bound radioactive substances released with the exhaust air. To this end the aerosol-bound radioactive substances shall be continuously accumulated on a high-efficiency particulate air filter of at least Filter Class H12 in accordance with DIN EN 1822-1. These filters shall be provided in duplicate form.

(2) The accumulation period shall not exceed one week.

(3) After their removal, the high-efficiency particulate air filters shall be analyzed within two days by a gamma spectrometric measurement. The radioactive decay occurring between accumulation and measurement shall be taken into account. The nuclides listed in **Table 3-2** shall be taken into account in the detailed assessment.

(4) The high-efficiency particulate air filter shall be measured without delay whenever one of the upper limit values of the exhaust air surveillance is reached. If automatically starting collectors are additionally installed, the filters of these collectors may be measured instead.

(5) The detection limit of the measurement equipment for determining the radioactivity concentration shall not exceed a value of $3 \cdot 10^{-2}$ Bq/m^3 for cesium 137. Those radionuclides listed in **Table 3-2** which do not register shall be specified with the decision limit of the particular measurement equipment for the corresponding measurement.

Radionuclide	Radionuclide
Chrome 51	Ruthenium 106
Manganese 54	Silver 110 m
Cobalt 57	Antimony 124
Cobalt 58	Iodine 131
Cobalt 60	Cesium 137
Zinc 65	Barium 140
Zirconium 95	Lanthanum 140
Niobium 95	Cerium 141
Ruthenium 103	Cerium 144

Table 3-2: Radionuclides to be considered in the detailed assessment of aerosol-bound radioactive substances

(6) The measurement duration for the detailed assessment shall correspond to at least that measurement duration required to achieve the detection limits specified under para. 5.

(7) Any other radionuclides detected with half-lives longer than eight days shall be specified in the reporting form (cf. **Figure 7-1**) under "Others".

Note:
The detailed assessment of the released iodine 131 is determined as specified under Section 3.4.2, of radioactive strontium as specified under Section 3.6 and of alpha emitters as specified under Section 3.7.

3.4 Radioactive Gaseous Iodine

3.4.1 Continuous Measurement

(1) The release of gaseous radioactive iodine with the exhaust air shall be surveilled by a continuous measurement. For this purpose, the iodine shall be continuously deposited from a partial stream on an iodine filter which shall be continuously measured for the radioactivity of the deposited iodine 131.

(2) The measurement equipment shall be designed such that, given a previously non-loaded filter, a short-term radioactivity concentration with a time integral of 2 $(Bq/m^3)h$ for iodine 131 will, within a maximum of one hour, cause the decision limit of either the alarm display of the measurement value "Radioactivity on the Filter" or "Increasing Radioactivity on the Filter" to be exceeded.

(3) The measurement range of the measurement equipment shall be such that it will be possible to determine discharge rates of iodine 131 from $4 \cdot 10^5$ through $4 \cdot 10^8$ Bq/h taking the nominal volumetric flow of the exhaust air into account.

(4) The radioactivity on the filter shall be surveilled with respect to a value at which a release of $4 \cdot 10^7$ Bq inside one hour can still be detected with a maximum standard deviation of 10 %. The filter shall be exchanged when this value is exceeded and the release cannot anymore be determined with a maximum standard deviation of 10 %.

(5) The separation efficiency and loading capacity of the filters shall be known both for elementary iodine as well as for organically bound iodine and shall be taken into account when choosing the sorption material. The sorption material used for iodine shall have a low rate of adsorption for noble gases.

Note:
In determining the separation efficiencies, the reference medium is, usually, the organic compound methyl-iodide.

(6) In order to prevent any distortion of the measurement, a high-efficiency particulate air filter in at least Filter Class H12 in accordance with DIN EN 1822-1 shall be installed in-line before the iodine filter.

3.4.2 Detailed Assessment

(1) A detailed assessment shall be performed for the iodine 131 released with the exhaust air. For this detailed assessment, elemental iodine and organically bound radioactive iodine in the exhaust air shall be accumulated on iodine filters by continuous filtration in such a way that a separate evaluation with regard to these two chemical forms is possible. These filters shall be provided in duplicate form.

(2) The separation efficiency and loading capacity of the filters shall be known both for elemental iodine as well as for organically bound iodine and shall be taken into account when choosing the filters.

(3) In order to prevent any distortion of a measurement value, a high-efficiency particulate air filter in at least Filter Class H12 in accordance with DIN EN 1822-1 shall be installed in-line before the iodine filter; this high-efficiency particulate air filter may be identical to the one specified under Section 3.3.2 para. 1.

(4) The accumulation period shall not exceed one week; the radioactive decay between accumulation and measurement shall be taken into account.

(5) For the detailed assessment of the released iodine 131, the radioactivity of iodine 131 on the iodine filter and on the high-efficiency particulate air filter specified under para. 3 shall be determined by measurements in a gamma ray spectrometer within a day after removing the filter. The filters shall be analyzed without delay if one of the limit values for surveilling the exhaust air is reached. If automatically starting collectors are additionally installed, the filters of these collectors may be measured instead.

(2) The detection limit for measuring the radioactivity concentration of gaseous iodine 131 shall not exceed $2 \cdot 10^{-2}$ Bq/m^3. The duration for this measurement shall correspond to at least that measurement duration required to achieve this detection limit.

3.5 Tritium

(1) Tritium released in the chemical compound form of water with the exhaust air shall be surveilled. This shall be carried out by a continuous accumulation of samples.

(2) The analysis for tritium shall be performed in quarter annual intervals. It may be performed on the basis of the individual samples extracted as specified under para. 1 or on the basis of one representative mixed sample.

(3) A detailed assessment shall be performed for the radioactivity of tritium released with the exhaust air. It shall be possible to detect a radioactivity concentration for tritium of 100 Bq/m^3 in the exhaust air.

(4) If the type of extracting samples requires that the temperature and humidity of the exhaust air be taken into account, then these values shall be continuously determined.

3.6 Radioactive Strontium

(1) With regard to the surveillance of the released radioactive strontium with the exhaust air, strontium shall be continuously deposited from a partial stream on a high-efficiency particulate air filter in at least Filter Class H12 in accordance with DIN EN 1822-1. This filter may be identical to the high-efficiency particulate air filter in accordance with Section 3.3.2 para. 1.

(2) The measurements for strontium 89 and strontium 90 shall be carried out in quarter annual intervals on mixed samples that may be prepared from high-efficiency particulate air filters exposed in the corresponding time period. In case of strontium 89, the radioactive decay between accumulation and measurement shall be taken into account.

(3) A detailed assessment shall be performed for the radioactive strontium discharged with the exhaust air. It shall be possible to detect a radioactivity concentration for strontium 89 and strontium 90 of $1 \cdot 10^{-3}$ Bq/m^3 in the exhaust air.

3.7 Alpha Emitters

(1) With regard to the surveillance of the released alpha emitting radioactive substances (alpha emitters) with the exhaust air, aerosol-bound alpha emitters shall be continuously deposited from a partial stream of the exhaust air on a high-efficiency particulate air filter in at least Filter Class H12 in accordance with DIN EN 1822-1. This filter may be identical to the high-efficiency particulate air filter in accordance with Section 3.3.2 para. 1.

(2) The nuclide specific analysis for alpha emitters shall be carried out in quarter annual intervals on mixture samples that may be prepared from the high-efficiency particulate air filters exposed in the corresponding time period.

(3) A detailed assessment shall be performed for the alpha emitters discharged with the exhaust air. In the detailed assessment the nuclides listed in **Table 3-3** shall be taken into account. The detection limit of the measurement equipment for determining the radioactivity concentration shall not exceed $5 \cdot 10^{-3}$ Bq/m^3 for americium 241. Those nuclides listed in **Table 3-3** which do not register shall be specified with the decision limits of the particular equipment for the corresponding measurement. The measurement duration for the detailed assessment shall correspond to at least that measurement duration required to achieve the detection limit specified for americium 241. In the detailed assessment it is permitted to group the nuclide pairs plutonium 238 and americium 241 as well as plutonium 239 and plutonium 240 together.

(4) Any other alpha emitters detected shall be specified in the reporting form (cf. **Figure 7-1**) under “Others”.

Radionuclide	Radionuclide
Plutonium 238	Americium 241
Plutonium 239	Curium 242
Plutonium 240	Curium 244

Table 3-3: Radionuclides to be considered in the detailed assessment of alpha emitters

3.8 Carbon 14

(1) Carbon 14 released in the chemical form of carbon dioxide with the exhaust air shall be surveilled. For this purpose, extraction samples shall be continuously accumulated from the exhaust air and measured in at least quarter annual intervals.

(2) The carbon 14 in the radiologically relevant chemical form of carbon dioxide released with the exhaust air shall be assessed in detail. It shall be possible to detect a quarter annual release of 10^9 Bq.

(3) The annual radioactivity release of carbon 14 shall be determined.

4 Sample Extraction

(1) The sample extraction location and sample extraction procedure shall be chosen such that the extracted samples are representative for the emissions to be surveilled. The number of sample extraction points is dependant on the degree of intermixing of the exhaust air at the location of the sample extraction point.

Note:
Details regarding the required number and the arrangement of the sample extraction locations are provided in DIN 25 423-2 (8/00).

(2) It is recommended that the volumetric flow of the partial air stream extracted from the exhaust air shall be smaller than one thousands of the nominal volumetric flow of the exhaust air.

Note:
Details regarding the choice of the partial air stream are provided in DIN 25 423-2 (8/00).

(3) The sample extraction lines shall be designed, located and from such materials that the aerosols and gaseous iodine compounds are retained a little as possible.

Note:
Details regarding the design are provided in DIN 25 423-2 (8/00).

(4) When selecting and storing the sorption material for the filters, the aging effects shall be taken into account. The specified temperature range shall be maintained.

(5) The design of the of aerosol and iodine filter components shall take the following points into account:

a) Gas leak tightness shall be ensured during operation. This is achieved if the volumetric flow of the leakage air at about 100 mbar is not larger than 1 % of the sample extraction partial volumetric flow.

b) Any damage to the filter in the region of the filter gasket and any bypass flow around the filter shall be avoided.

c) The filters shall be easily exchangeable.

d) The mechanical parts shall be resistant to corrosion.

e) Those parts of the filter mounting that contact the measurement medium shall be easily decontaminated.

(6) In case the sample extraction is performed discontinuously, the point in time and duration of the sample extractions shall be chosen such that the extracted samples are representative for the radioactive substances discharged between two consecutive sample extractions.

(7) The sample extraction equipment for the continuous accumulation of aerosol-bound radioactive substances shall be designed such that a spectrum of aerosol particles with aerodynamically equivalent diameters in the range of 0.1 to 20 µm will reach the high-efficiency particulate air filter. The cumulative loss factor of the manufactured sample extraction equipment with respect to aerosol-bound radioactive substances shall be determined. Suitable methods are, e.g.:

a) The cumulative loss factor of aerosol-bound radioactive substances shall be determined with test aerosol particles where the particle size distribution of the specific material type is characterized by a median of about 1 µm for the aerodynamically equivalent diameter and by a standard geometric deviation of between 2 and 3. The test aerosol particles shall be injected into the exhaust air duct and the cumulative loss factor subsequently determined from the injected quantity and the quantity found on the accumulating medium.

b) The cumulative loss factor for the aerosol-bound radioactive substances may be determined alone on the basis of the pipe factor for the particle size distribution required under a). The pipe factor may also be determined with the plant internal aerosols in the exhaust air stack at the sample extraction location. In this case, the other influence parameters required for determining the cumulative loss factor shall be determined by special measurements or by calculations.

c) The cumulative loss factor of the aerosol-bound radioactive substances shall be determined by comparing the radioactivity concentration measured directly in the exhaust air stack with the measurement values of the radioactivity concentration determined from the accumulation and measurement equipment.

Measurement Task	Measurement Procedure	Re-dun-dancy	Measurement or Accumulat-ing Equipment	Measurement Range (at nominal volumetric flow)	Detection Limit	Remarks
Noble Gases a) continuous measurement	a1) integral continuous or: a2) integral continuous	yes yes	ß- and γ-detector 2 · ß-detector	$4 \cdot 10^9$ to $4 \cdot 10^{13}$ Bq/h	$1 \cdot 10^4$ Bq/m³ for Xe 133	
b) detailed as-sessment	nuclide specific continuous or: nuclide specific discontinuous in combination with integral continuous	no no	γ-detector γ-detector ß-detector		$5 \cdot 10^2$ Bq/m³ for Xe 133 $1 \cdot 10^4$ Bq/m³ for Kr 85	permissible as re-dundancy for the ß-detector under a1) permissible only in combination with a2) measurement equipment similar to that under a) “con-tinuous measure-ment”
Aerosol-bound Radioactive Sub-stances a) continuous measurement b) detailed as-sessment	integral continuous discontinuous	no yes	γ- or ß-detector accumulating filter	$4 \cdot 10^6$ to $4 \cdot 10^9$ Bq/h	4 (Bq/m³)h for Cs 137 $3 \cdot 10^{-2}$ Bq/m³ for Cs 137	cf. Sec. 3.3.1 (6) cf. Sec. 3.3.2 (5)
Iodine a) continuous measurement b) detailed as-sessment	nuclide specific for iodine 131 discontinuous	no yes	γ-detector accumulating filter	$4 \cdot 10^5$ to $4 \cdot 10^8$ Bq/h	2 (Bq/m³)h $2 \cdot 10^{-2}$ Bq/m³	cf. Sec. 3.4.1 (2) cf. Sec. 3.4.2 (6)
Tritium detailed assess-ment	discontinuous	no	accumulator		$1 \cdot 10^2$ Bq/m³	
Strontium detailed assess-ment	discontinuous	yes	accumulating filter		$1 \cdot 10^{-3}$ Bq/m³	the radioactive strontium isotopes on the high-particulate air filter shall be analyzed, cf. Sec. 3.6 (2)
Alpha Emitter detailed assess-ment	discontinuous	yes	accumulating filter		$5 \cdot 10^{-3}$ Bq/m³	the alpha emitters on the high-particulate air filter shall be analyzed, cf. Sec. 3.7 (2)
Carbon 14 (as CO_2)	discontinuous	no	accumulator		$1 \cdot 10^9$ Bq quarter annually	cf. Sec. 3.8 (2)
Carbon 14 (total)	discontinuous	no	accumulator		$5 \cdot 10^9$ Bq annually	cf. Sec. 3.8 (3)

Table 3-4: Surveillance of the release of radioactive substances with the exhaust air

(8) The cumulative loss factor shall be determined upon commissioning of the sample extraction equipment, after any changes that could essentially influence the cumulative loss factor as well as every five years. Its value shall normally not be larger than 2 and it shall not be larger than 3.

(9) The cumulative loss factor shall be taken into consideration in the detailed assessment of the released aerosol-bound radioactive substances.

(10) The sample extraction equipment including the filter shall be designed and installed such that no temperatures can occur lower than the dew point.

5 Design and Construction of the Stationary Surveillance Equipment

5.1 Design and Installation

(1) All components of the surveillance equipment, e.g. sample extraction equipment, measuring instruments, and transducers, shall be designed such that they can be operated as specified under this safety standard at the ambient conditions and measurement media conditions occurring at their installation location.

(2) The measurement and sample extraction equipment shall be installed and housed such that (a) the nominal operating ranges specified in the individual equipment specifications are maintained and that (b) tests and examinations, maintenance and repair are easily possible.

(3) Upon variation of any one influence quantity within the nominal operating ranges specified in **Table 5-1**, the measurement value shall not vary by more than ± 30 % of that measurement value determined at the reference value of this influence quantity. With this variation, all other influence parameters – with the exception of the atmospheric pressure and the pressure of the measurement medium – shall, as far as possible, remain unchanged in the vicinity of the calibration reference values. Here, the pressure difference between the measurement medium and the environment shall normally not exceed 200 hPa.

(4) The reference values specified in **Table 5-1** shall be used for the corresponding influence parameters. The reference value for the filter loading is the non-loaded condition. The manufacturer of the surveillance equipment shall specify the reference value for background radiation.

(5) In case of a failure of the air conditioning in the measurement rooms, the calibration value shall not vary by more than ± 30 % within the first hour after the failure taking the ambient conditions to be expected into account.

(6) With regard to the disturbance resistance of the measurement equipment against electromagnetic influences, e.g., electrostatic discharges, electromagnetic fields, interference voltages, the Act on the Electromagnetic Compatibility of Equipment (EMVG) shall be taken into account.

(7) The measurement devices of the continuously operated surveillance equipment shall normally and as far as possible be installed or housed in central measurement rooms.

(8) In case an operating medium, e.g. counter gas, is required then the supply of the operating medium shall be ensured and shall be surveilled with regard to a possible failure.

Influence Parameters	Nominal Operating Range	Reference Value
Operating voltage		
alternating current voltage supply	85 to 110 % of the nominal value of the operating voltage	Manufacturer specification
direct current voltage supply	specified voltage range of the direct current voltage grid	Manufacturer specification
Ambient temperature in °C	15 to 40	20
Ambient air pressure in hPa	900 to 1100	Manufacturer specification
Relative humidity of ambient air in %	10 to 95, non-dewing	60
Temperature of the measurement medium in °C	15 to 40	20
Pressure of the measurement medium[1)] in hPa	700 to 1100	Manufacturer specification
Relative humidity of the measurement medium in %	10 to 95, non-dewing	60

1) Pressure difference between the ambient atmosphere and the measurement medium shall not be larger than 200 hPa.

Table 5-1: Nominal operating range and reference values of the influence parameters

(9) All electrical power utilization devices shall be connected to the emergency power supply system. Redundant electrical power utilization devices shall be connected to redundant bus bars.

(10) Surveillance equipment that are operated continuously shall be designed and constructed as self-monitoring units; it shall be ensured that the switch-over to the emergency power supply does not interrupt the processing of measurement values in such a way that stored data, e.g. measured quantities to be used for an integration, would get lost.

(11) All radiation and radioactivity surveillance equipment including their peripheral equipment shall restart automatically after a power interruption.

(12) In the case that measurement equipment is installed on or inside a bypass, the flow through this bypass shall be surveilled.

(13) The measurement equipment for the integral determination of noble gases as well as the ventilators for the extraction of a partial flow from the exhaust air as also the filters for the detailed assessment of the released aerosol-bound radioac-

tive substances and of radioactive iodine shall be provided as twice redundant equipment.

5.2 Statistical Certainty

(1) The factor for the statistical certainty at the decision limit, k_E, shall be equal to 1.645 in the case of non-cumulating continuous measurements and equal to 3.0 in the case of accumulating continuous measurements (Section 3.3.1 para. 1 and Section 3.4.1 para. 1) as well as of the measurements for all detailed assessments.

(2) The factor for the statistical certainty at the detection limit, k_N, shall be equal to k_E + 1.645 for the measurements specified under para. 1.

5.3 Limit Values

(1) If it is necessary to readjust devices during operation then the adjustment possibilities shall be provided in the form of built-in fixtures. All adjustment possibilities on the electronic devices of surveillance equipment shall be arranged and secured in such a way that a maladjustment by non-authorized personnel can be precluded to a large extent. Any self-adjustment by the equipment itself shall be impossible.

(2) Any value below the lower limit value for signaling equipment failure or any value exceeding an upper limit value shall be optically displayed and acoustically annunciated in the control room. Collective alarms are permitted, provided, the measurement location originating the alarm is displayed in the control room or in a control room annex. The acoustic alarms may be cancelled individually or collectively before the cause of the alarm is remedied.

(3) The optical alarms in the control room that signal a failure or that an upper limit value was exceeded shall be such that the alarm status can be detected.

5.4 Display and Recording of the Measurement Values

(1) In case of an analog display, the measurement equipment shall normally have only one display range for each measured quantity. If more than one display range is necessary, it is required that,

a) in the case of multiple linear display ranges, the measurement ranges shall overlap each other by at least 10 % and the measurement-range factor shall not be larger than 10,

b) in the case of multiple logarithmic display ranges, the measurement ranges shall overlap each other by at least one decade.

(2) It is recommended that the measurement value is displayed on the measurement equipment itself. The following values shall be displayed and automatically recorded In the control room:

a)	exhaust air:	volumetric flow,
b)	radioactive noble gases:	radioactivity concentration, discharge rate (Bq/h),
c)	aerosol-bound radioactive substances:	filter loading (radioactivity), in the case of devices with a fixed filter: change of radioactivity per unit time,
d)	radioactive iodine:	filter loading (radioactivity), radioactivity concentration, discharge rate (Bq/h).

(3) In case of an analog display of the values it shall be ensured that the maximum permissible value for the decision limit specified under this safety standard is clearly visible, i.e., that it is displayed at least 3 mm above the expected value of a background measurement. Here, it is permissible to apply suitable countermeasures, e.g., a background compensation.

(4) The automatically recorded data on the chart paper shall remain directly in view and well legible for a time period of at least 3 hours.

(5) The measurement values may be displayed in the control room on CRT monitors, provided, that one monitor is dedicated primarily to the display of these values, that a copy of the screen display can be printed out at all times and that the values are stored. A second monitor shall be available as redundancy. The display on the monitor shall, in analogous form, meet the requirements specified under paras. 1 through 4.

5.5 Testability

The surveillance equipment shall be designed and constructed such that the perfect functioning order of the individual devices can be verified within the framework of the initial tests specified under Section 6.2.2 and of the inservice inspections specified under Section 6.2.3. It shall be possible to perform functional tests even during full power operation of the nuclear power plant.

6 Maintenance of the Stationary Surveillance Equipment

6.1 Servicing and Repair

6.1.1 Execution

Servicing and repair of the surveillance equipment shall be executed by qualified personnel and in accordance with the individual operating and maintenance instructions.

6.1.2 Documentation

All servicing and repair tasks shall be documented. The documentation shall contain the following information:

a) unambiguous identification of the surveillance equipment involved,

b) type of the servicing or repair task performed,

c) type and number of the exchanged parts,

d) reasons for exchanging the parts,

e) regarding the exchanged parts: date and identification of the regular test certificates and of the test certificates required under this safety standard,

f) information on the outage times,

g) date of executing the servicing or repair task,

h) name and signature of the qualified personnel.

6.2 Tests and Inspections

6.2.1 Test and inspections to be performed

The surveillance equipment shall be subjected to the following tests and inspections:

a) prior to deployment in a nuclear power plant:

   aa) certification of the suitability,

   ab) calibration,

b) prior to their first deployment in a particular nuclear power plant:

   ba) verification of the suitability,

   bb) factory test,

   bc) verification of the calibration with solid calibration sources,

   bd) commissioning tests and inspections,

c) in course of deployment in the nuclear power plant
   ca) regular inservice inspections,
   cb) tests and inspections after servicing and repair tasks.

6.2.2 Initial Tests and Inspections

6.2.2.1 Certification of Suitability

(1) Prior to their initial deployment in a nuclear power plant, it shall be demonstrated that the surveillance equipment fulfill their objective and meet the specified requirements.

(2) The certification of suitability comprises a (plant independent) verification of the equipment characteristics and a plant dependent suitability test..

(3) The certification of the equipment characteristics shall be performed either on the basis of satisfactory operational experience, of available test certificates, of an extended commissioning test, or within the framework of a type test. In substantiated individual cases, e.g. new development of measurement equipment, this certification may also be performed by other means.

(4) The tests and examinations shall be performed by authorized experts.

Note:
Requirements regarding “Certification of Suitability of Radiation Measuring Equipment” are provided in KTA 1505 (E 6/02).

6.2.2.2 Calibration

(1) Suitable calibration factors shall have been established for the surveillance equipment including the measurement equipment for the volumetric flow prior to their initial deployment. The calibration factors may also be determined on type-identical measurement equipment. The calibration shall be performed at the reference values specified in **Table 5-1**.

(2) The measurement equipment for surveilling the overall beta radioactivity of the radioactive noble gases shall be calibrated using xenon 133 and krypton 85. The energy dependency of the response characteristics of the measurement equipment for determining the beta radiation of the radioactive noble gases shall be determined using at least three representative beta emitters with a maximum beta energy in the range from 150 keV to 2500 keV. The energy dependency of the response characteristics of the measurement equipment for determining the gamma radiation of radioactive noble gases shall be known for gamma radiation in the energy range from 60 keV to 2500 keV.

(3) The measurement equipment for the surveillance of the beta radiation of the aerosol-bound radioactive substances shall be calibrated both with technetium 99 or cobalt 60 as well as with chlorine 36 or cesium 137, and the measurement equipment for gamma radiation with barium 133 and cesium 137. The energy dependency of the response characteristics for beta radiation shall be known in the energy range from 150 keV to 2500 keV and for gamma radiation in the energy range from 100 keV to 1700 keV. In order to reduce the probability of detecting falsifying nuclides and background radiation, the lower threshold for gamma radiation in measurement equipment for surveilling aerosol-bound radioactive substances may be raised up to a maximum of 250 keV.

(4) The measurement equipment for the surveillance of iodine shall be calibrated with iodine 131.

(5) The measurement equipment for the surveillance of water-bound tritium shall be calibrated with tritiated water.

(6) The measurement equipment for [the surveillance of] alpha emitters shall be calibrated with americium 241.

(7) During initial calibration a set of solid calibration sources shall be specified with each one of which one display value can be checked in one of the lower and one of the upper decades of the measurement range. For this purpose, the following solid calibration sources shall be provided:

a) for the surveillance of noble gases: cobalt 60 or technetium 99 for the beta radiation measurement equipment and barium 133 or cobalt 57 for the gamma radiation measurement equipment,
b) for the surveillance of aerosol-bound radioactive substances: cobalt 60 or technetium 99 for the beta radiation measurement equipment and barium 133 or cobalt 57 for the gamma radiation measurement equipment,
c) for the iodine surveillance: barium 133.

(8) Following the initial calibration of the surveillance equipment, a solid calibration source shall be used in a defined and reproducible geometry to determine a display value which will later make it possible to verify the calibration and to connect type identical equipment.

6.2.2.3 Factory Test

(1) A factory test shall be performed to verify that the surveillance equipment was properly manufactured in accordance with regulations and is in perfect functioning order. In case the surveillance equipment is comprised of components from different manufacturers, then the proper manufacturing and functioning order of these components shall be verified by factory tests at the individual manufacturers.

(2) The factory test shall be performed as a production test and shall comprise:

a) visual inspection,
b) test of the output value as a function of the specified fluctuation of the operating voltage,
c) test of the response characteristic with a pulse or current generator and at least one test value for each decade of the measurement range,
d) test of the overload resistance (by electronic means or by using a calibration source),
e) test of proper functioning by use of a solid calibration source,
f) volumetric flow measurement,
g) leak-tightness measurement.

(4) The factory test shall be performed by plant experts and, in justified cases, in the presence of experts authorized by the proper authority.

6.2.2.4 Commissioning Tests

(1) The post-installation commissioning tests shall demonstrate the proper design and function of the surveillance equipment. The following items shall be tested:

a) design of the surveillance equipment,
b) installation of the surveillance equipment,
c) display (with a pulse or current generator and at least one test value for each decade of the measurement range),
d) verification of the calibration (with a solid calibration source),
e) connection to the emergency power system,
f) volumetric flow surveillance,
g) measured value processing (alarms),
h) supply of operating media,
i) equipment failure alarms,
k) limit value settings,
l) automatic restart after interruption of the power supply,
m) connection with the exhaust air volumetric flow.

(2) The commissioning test shall be carried out by the plant operator and, to an extent specified by the proper authority, by authorized experts or in their presence.

6.2.3 Inservice Inspections

6.2.3.1 General Requirements

(1) The type, extent and intervals of the tests and inspections shall be specified in documents that are in accordance with KTA 1202.

(2) Those functional tests that necessitate a removal of safety relevant interlocks shall be coordinated with the proper authority.

(3) The tests and inspections shall be possible without any changes to the circuitry, e.g. soldering.

6.2.3.2 Regular Inservice Inspections

(1) Regular inservice inspections shall be performed to verify proper functioning of the surveillance equipment. The tests and test intervals shall be as specified in **Table 6-1**.

(2) The verification of the calibration under running number 1 b) of **Table 6-1** shall be carried out with the calibration source and defined geometry during initial calibration of the measurement equipment as specified under Section 6.2.2.2. The required value of the display shall be achieved with an accuracy as specified in the testing manual.

Running Number	Test Object	Test Procedure	Test Frequency	
			by the plant operator	by the expert authorized by the proper authority
1	Surveillance equipment	a) Visual inspection b) Calibration verification with solid calibration source, in case of counter tubes: verification of the plateau, as necessary	during inspection rounds quarter annually -	annually annually annually
2	Testing and maintenance records	Visual inspection	-	annually
3	Electronic subunits	Insertion of standard signals into the transmitters (at least one value in each decade of the measurement range) [1]; comparison of all displays and recordings	annually	annually
4	Alarm signals	Operational availability: visual inspection Failure alarm signal: by interrupting the voltage supply or interrupting the signal connection between measurement transducer and detector Danger alarm signal: by radiation source or electrically	during inspection rounds quarter annually quarter annually	annually annually annually
5	Flow monitoring and supply of operating media			
	without automatic function control	Visual inspection	during inspection rounds	annually
	with automatic function control	Comparison of required values with the actual values	quarter annually	annually
6	Volumetric flow of exhaust air	Comparison of required values with the actual measurement of the volumetric flow	annually	annually
7a	Sample extraction system	Visual inspection and check of the ventilators or blower switching	annually	annually
7b	Sample extraction system	Determination of the cumulative loss factor	every 5 years	every 5 years

[1] The test procedure of inserting at least one standard signal into the transmitters for each decade of the measurement range is not required in the case of digital measurement equipment, provided, the software program is certified and of a self-monitoring nature. In this case it is sufficient to insert a single signal in the uppermost decade of the measurement range, provided, the pre-processing electronics do not require any switching procedures throughout the entire measurement range. This too is not required if the verification of the calibration is carried out with one measurement value in the uppermost decade of the measurement range.

Table 6-1: Regular inservice inspections

6.2.3.3 Post-Repair Testing

After a repair task the proper functioning shall be verified by a commissioning test as specified under Section 6.2.2.4 with an extent corresponding to the repair task.

6.3 Removal of Defects

Any defects identified by the tests and inspections shall be removed without delay and within the time limits specified in the test records.

6.4 Test Records

All tests and inspections performed shall be documented by test records. The test records shall be properly stored.
They shall contain at least the following information:

a) test object,

b) type of test,

c) test documents,

d) test results,

e) in case of defects: set time limits for the removal of defects or for the replacement of the test object,

f) date of the test,

g) name and signature of the tester.

7 Measurement Results

7.1 Documentation

7.1.1 Flow Chart

(1) The installed sample extraction and surveillance equipment required for surveilling the discharged gaseous and aerosol-bound radioactive substances shall be clearly presented in a flow chart. The different types of sample extractions and surveillance measurements shall be identified by different symbols.

(2) The required measurement objectives and means of measurement of each sample extraction and surveillance equipment shall be described (e.g. in tabular form) with the descriptions to be correlated to the flow chart. With regard to the sample extraction equipment, the objective, type, location and frequency as well as required measurements shall be listed. With regard to the surveillance equipment, the measurement objectives and technical measurement requirements, especially, the type of measurement, the arrangement of the measurement equipment including radiation shielding, calibration, measurement ranges, detection limits and measurement uncertainties shall be listed. With regard to the measurement laboratory, the measurement tasks and technical measurement requirements shall, likewise, be described.

7.1.2 Extent

The documentation shall be structured such that the release of radioactive substances can be completely verified. This documentation shall include records on

a) radioactivity measurements
(individual nuclide concentrations and discharge rates),

b) sample extractions
(continuous, discontinuous; point in time, time span),

c) exhaust air
(volume, point in time, time span),

d) responsible and performing personnel.

7.2 Report to the Proper Authorities

7.2.1 Contents

The report to the proper supervisory authority on the release of gaseous and aerosol-bound radioactive substances shall include:

a) volume of exhaust air,

b) licensed limit values,

c) nuclide specific radioactivity release and

d) the minimum and maximum decision limits achieved with the deployed measurement equipment in the reporting period.

7.2.2 Detailed Assessment

The nuclide specific proof of the radioactivity released in the exhaust air and the comparison with the licensed limit values shall be prepared quarter annually and for the time span since the beginning of the year. Those nuclides with concentrations below the decision limit do not need to be considered in the detailed assessment.

7.2.3 Reporting Form

(1) The reporting form shown in **Figure 7-1** shall normally be used for the regular reports.

(2) The column "Discharged Radioactivity" shall list only those values that result from measurement values exceeding the decision limits.

NPP:	In the ..... quarter, 20.. Since the beginning of the year 20..					
Volume of exhaust air in m³						
Nuclide	Decision limit (Bq/m^3)		Discharged Radioactivity (Bq)		Licensed Value (Bq/a)	Remarks
	min.	max.	in quarter	since beginning of the year		
Noble Gases: Ar 41 Kr 85 Kr 85m Kr 87 Kr 88 Kr 89 Xe 131m Xe 133 Xe 133 m Xe 135 Xe 135m Xe 137 Xe 138 Others Sum total of noble gases [1)] Total beta radioactivity [2)]						
Iodine: I 131 gaseous, elemental I 131 gaseous, organically bound I 131 aerosol bound Sum total of iodine 131 Others, gaseous Others, aerosol bound						
Aerosols: Cr 51 Mn 54 Co 57 Co 58 Fe 59 Co 60 Zn 65 Zr 95 Nb 95 Ru 103 Ru 106 Ag 110m Sb 124 Cs 134 Cs 137 Ba 140 La 140 Ce 141 Ce 144 Others *without iodine nuclides* Sum total						
Sr 89 Sr 90						
Tritium						
Alpha Emitters: Pu 238 Pu 239 Pu 240 Am 241 Cm 242 Cm 244 Others Sum total						
Carbon 14 As CO_2 Total						

[1)] In case of continuous nuclide specific measurement for the detailed assessment
[2)] In case of a discontinuous nuclide specific measurement for the detailed assessment

Figure 7-1: Report Form for Discharged Radioactivity

Appendix

Regulations Referred to in this Safety Standard

Regulations referred to in this safety standard are only valid in the version cited below. Regulations which are referred to within these regulations are valid only in the version that was valid when the later regulations were established or issued.

Atomic Energy Act		Act on the peaceful utilization of atomic energy and the protection against its hazards (Atomic Energy Act) of December 23, 1959 (BGBl. I, p. 814) in the version of July 15, 1985 (BGBl. I, p. 1565), most recently changed by Act of April 22, 2002 (BGBl. I, 2002, No. 26)
StrlSchV		Ordinance on the protection from damage by ionizing radiation (Radiological Protection Ordinance - StrlSchV) of July 20, 2001 (BGBl. I, 2001, p. 1714)
EMVG		Act on the electromagnetic compatibility of equipment (EMVG) of September 18, 1998 (BGBl. I, p. 2882)
KTA 1202	(06/84)	Requirements for the testing manual
KTA 1502.1	(06/86)	Monitoring radioactivity in the inner atmosphere of nuclear power plants; Part 1: Nuclear power plants with light water reactors
DIN EN 1822-1	(7/98)	High efficiency particulate air filters (HEPA and ULPA) – Part 1: Classification, performance testing, marking; German version EN 1822-1:1998
DIN 25 482-7	(12/97)	Detection limit and decision threshold for ionizing radiation measurements - Part 7: Counting measurements on filters during accumulation of radioactive materials